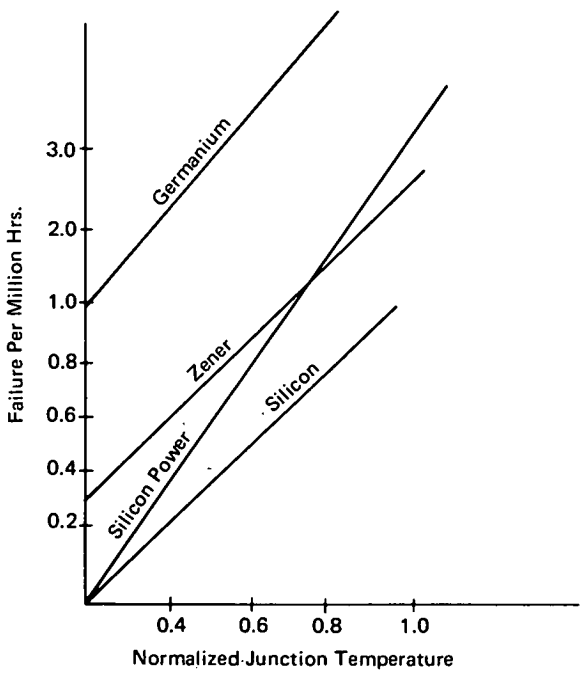
NASA TECH BRIEF

Lyndon B. Johnson Space Center

An Improved Method for Obtaining a Normalized Junction Temperature for Semiconductors: A Concept

The problem:

To date, reliability of semiconductors has been determined through laborious, expensive, and time consuming computations. Typically a knowledge of thermal resistance and of actual junction temperature are required to compute the basic reliability indicator, the normalized junction temperature. For a trade-off study of various stress loads and temperatures to which the device will be subjected, it is also necessary to calculate the actual power dissipation of the device.



Failure Rate For Different Semiconductor Devices
As A Function Of Normalized Junction Temperature

The solution:

Most of these calculations have become unnecessary as a result of a recently developed method. No longer is there a need to know the thermal resistance and actual power dissipation of the device to determine the normalized junction temperature.

How it's done:

Failure rates for different semiconductor devices have already been established (see figure) as a function of normalized junction temperature. Hence, the only question remaining is to determine the value of normalized junction temperature for any given device. The equation for normalized junction temperature T_n is given by

$$T_n = \frac{(T_A - T_S) + S(T_{j(max)} - T_A)}{T_{j(max)} - T_S}$$

where T_A is the ambient temperature; T_S is the temperature at which the power derating begins, usually at 25° C; S is the stress ratio; and $T_{j(max)}$ is the maximum rated junction temperature. With T_S = 25° C, this equation has been processed by computer for all practical combinations of T_A, S, and $T_{j(max)}$. As a result, about 1600 values of T_n have been printed out. Now failure rate for a given semiconductor device is simply determined by reading the value of T_n from the printout for any given combination of T_A, S, and $T_{j(max)}$ and obtaining the corresponding failure rate from the graph (see figure).

(continued overleaf)

Note:

Requests for further information may be directed to:

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Patent status:

NASA has decided not to apply for a patent.

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